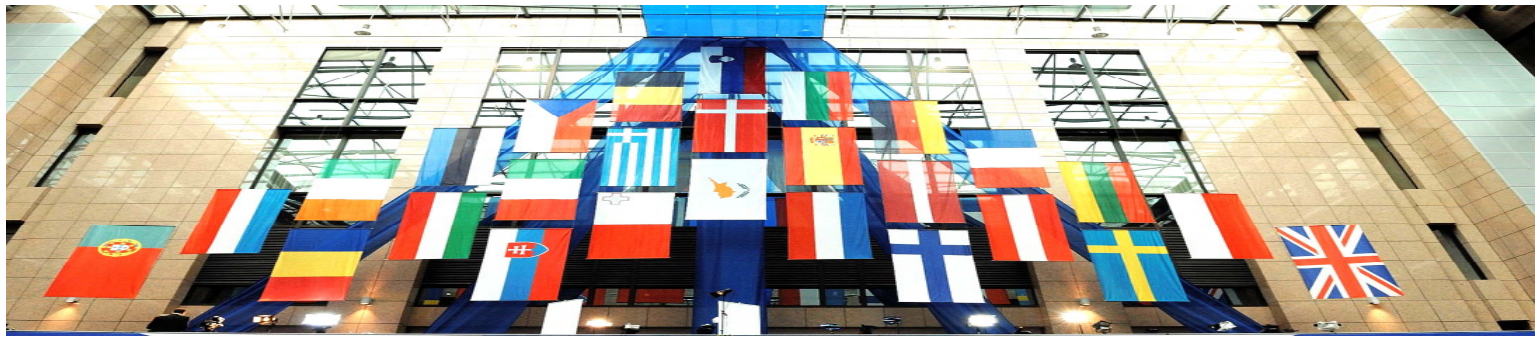
Objective ICT-2009.3.3
New paradigms for Embedded Systems, Monitoring and Control *towards* Complex Systems Engineering

Philippe Reynaert
Project Officer
Unit G3: Embedded Systems and Control

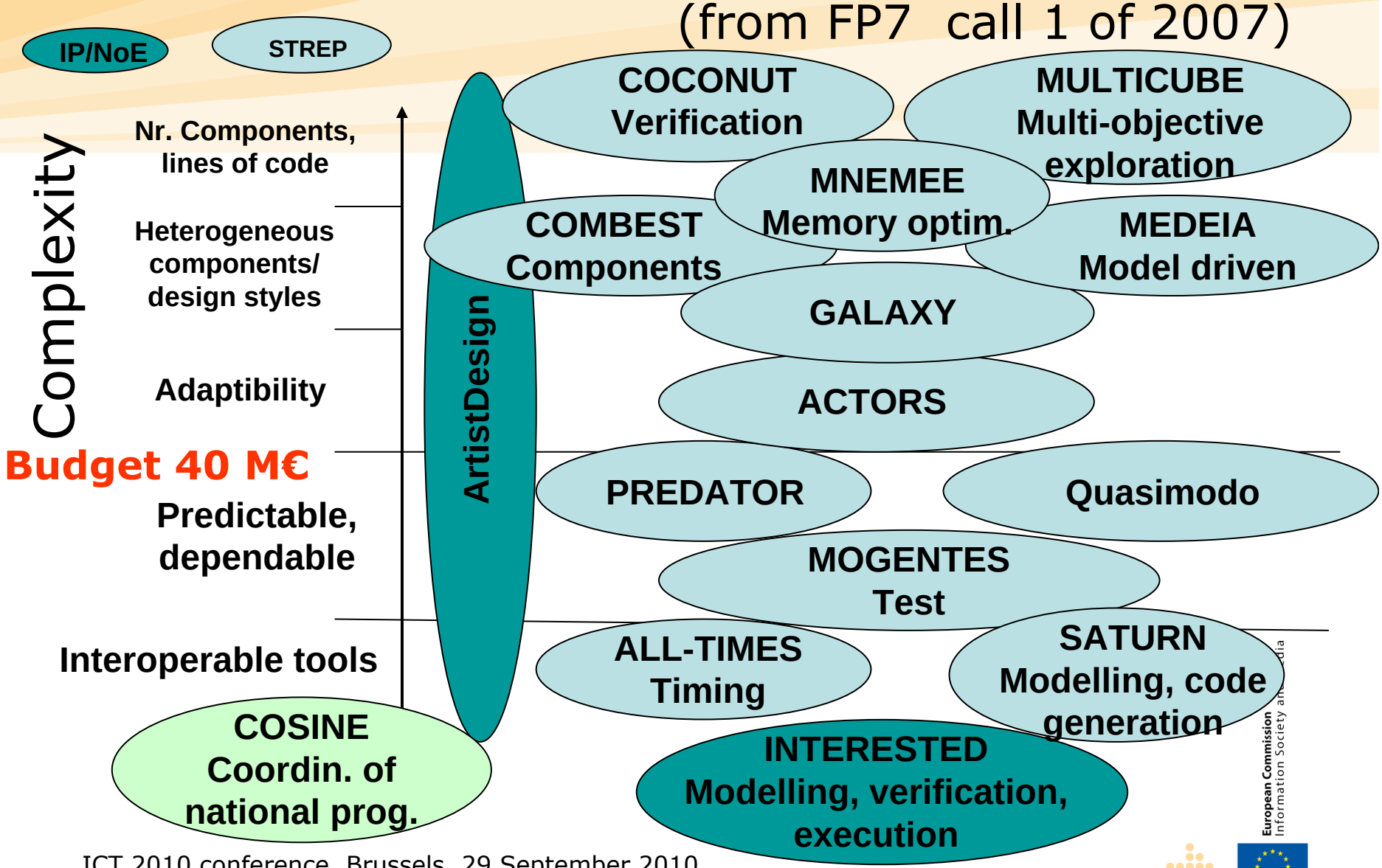
European Commission
Information Society and Media

Outline of the presentation

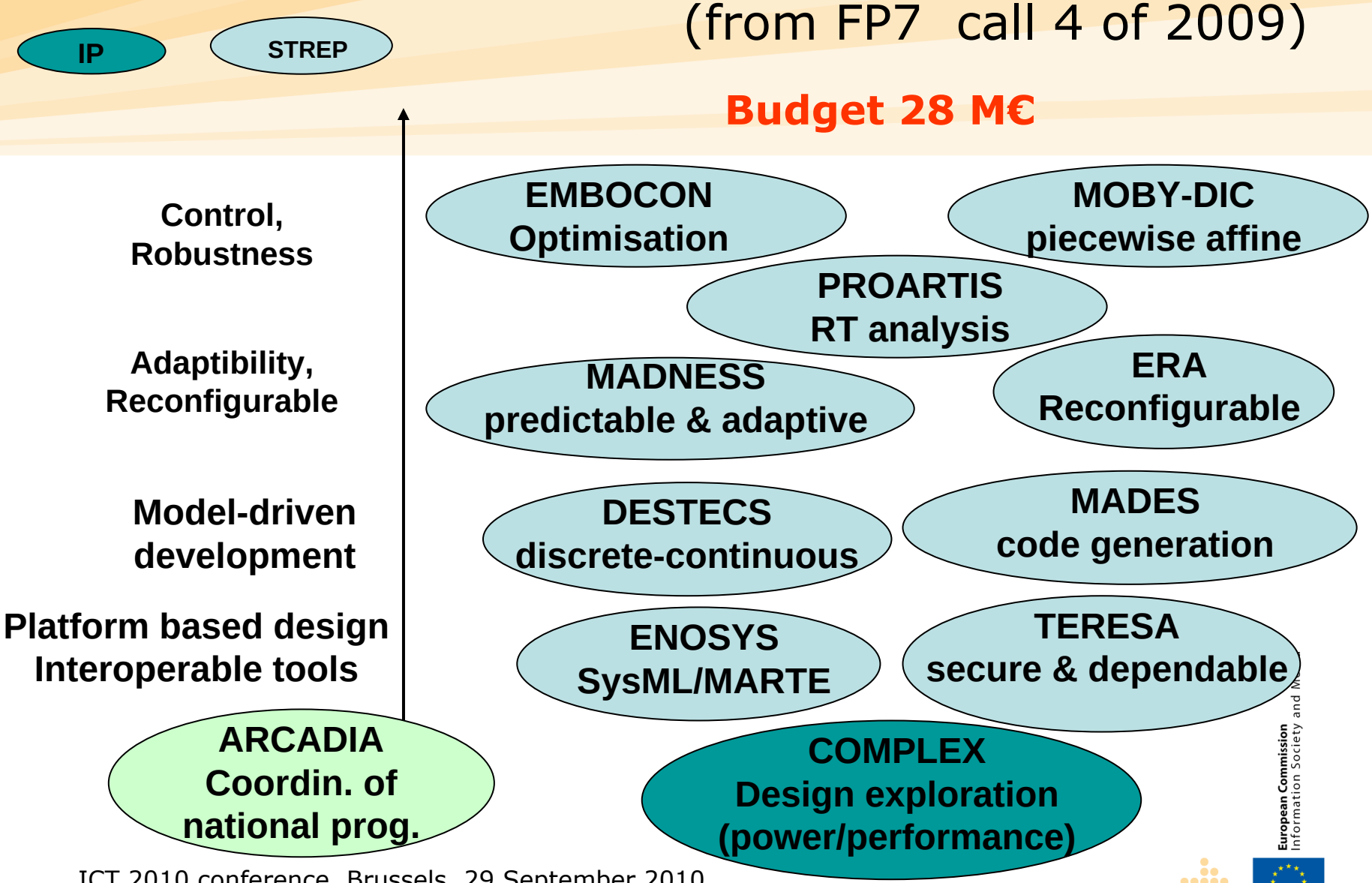
- Background calls and projects
- WP objective 3.3
- What is System-of-Systems (SoS)? Why?
- Target outcomes of WP objective 3.3
- Expected impact and evaluation criteria



Portfolio of Embedded Systems Design projects (from FP7 call 1 of 2007)

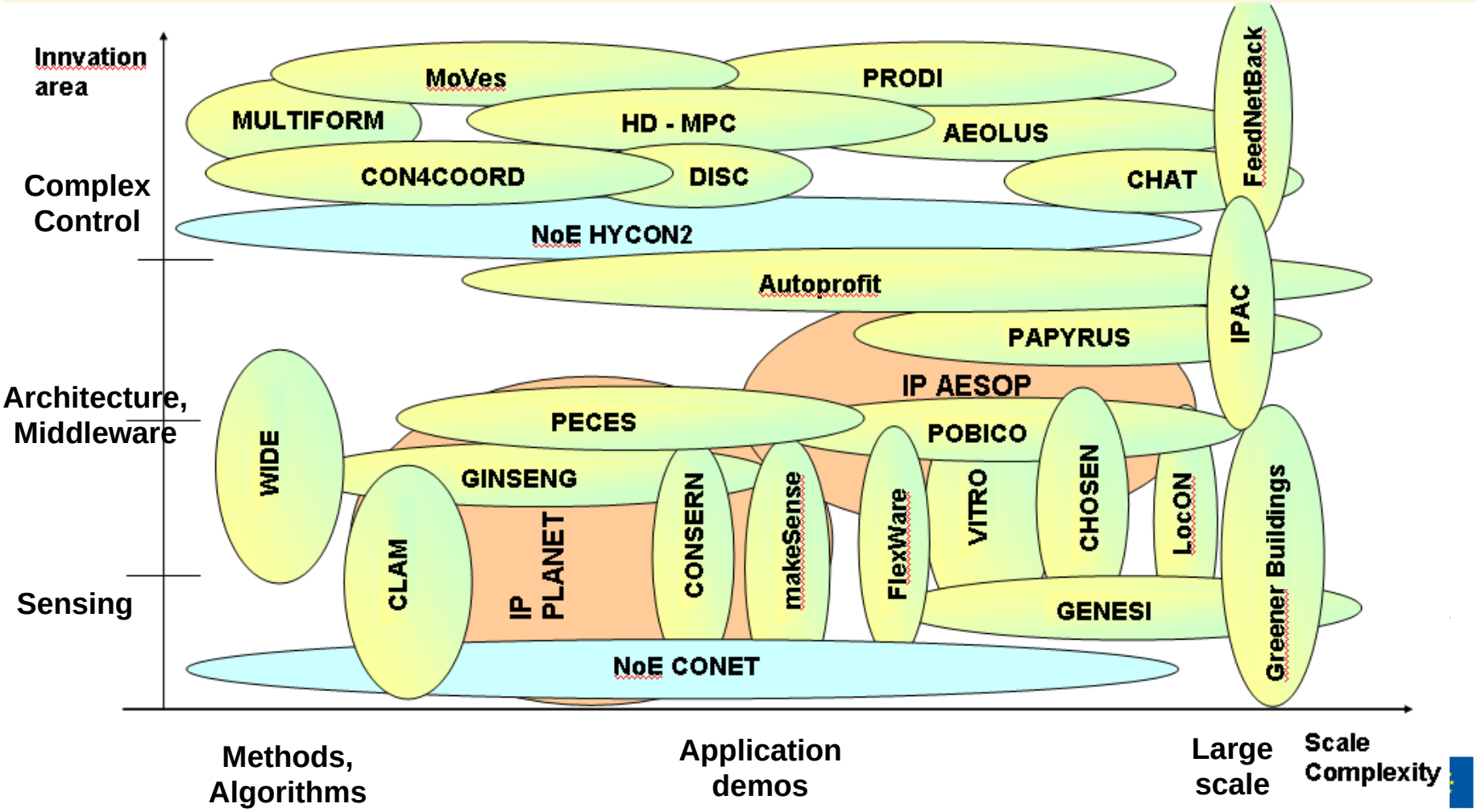


Portfolio of Embedded Systems Design projects (from FP7 call 4 of 2009)



Portfolio of M&C projects

(from FP7 call 3-5 as of 2010)



WP 2010-2011 Preparation

Input from:

- Consultation workshops
  - 21 September 2009 on System-of-Systems
  - 5-9 October 2009 on Monitoring and Control (Control of Large Scale Systems, Networked Monitoring and Control, Wireless Sensor Networks and Cooperative Objects)
  - 2-4 June 2010 on Monitoring and Control
- Analysis of previous call proposals (of ICT and ARTEMIS) and projects
- Member states and Associated states

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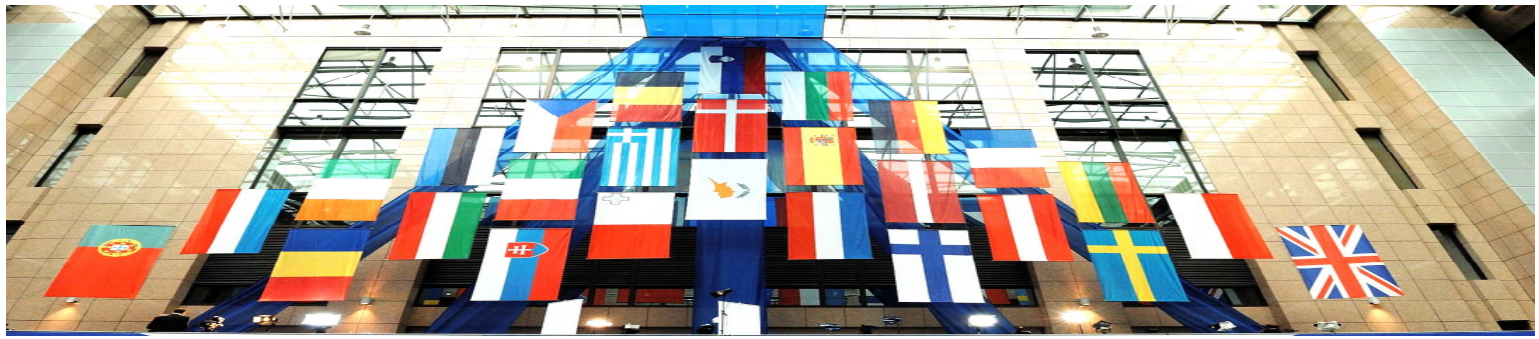
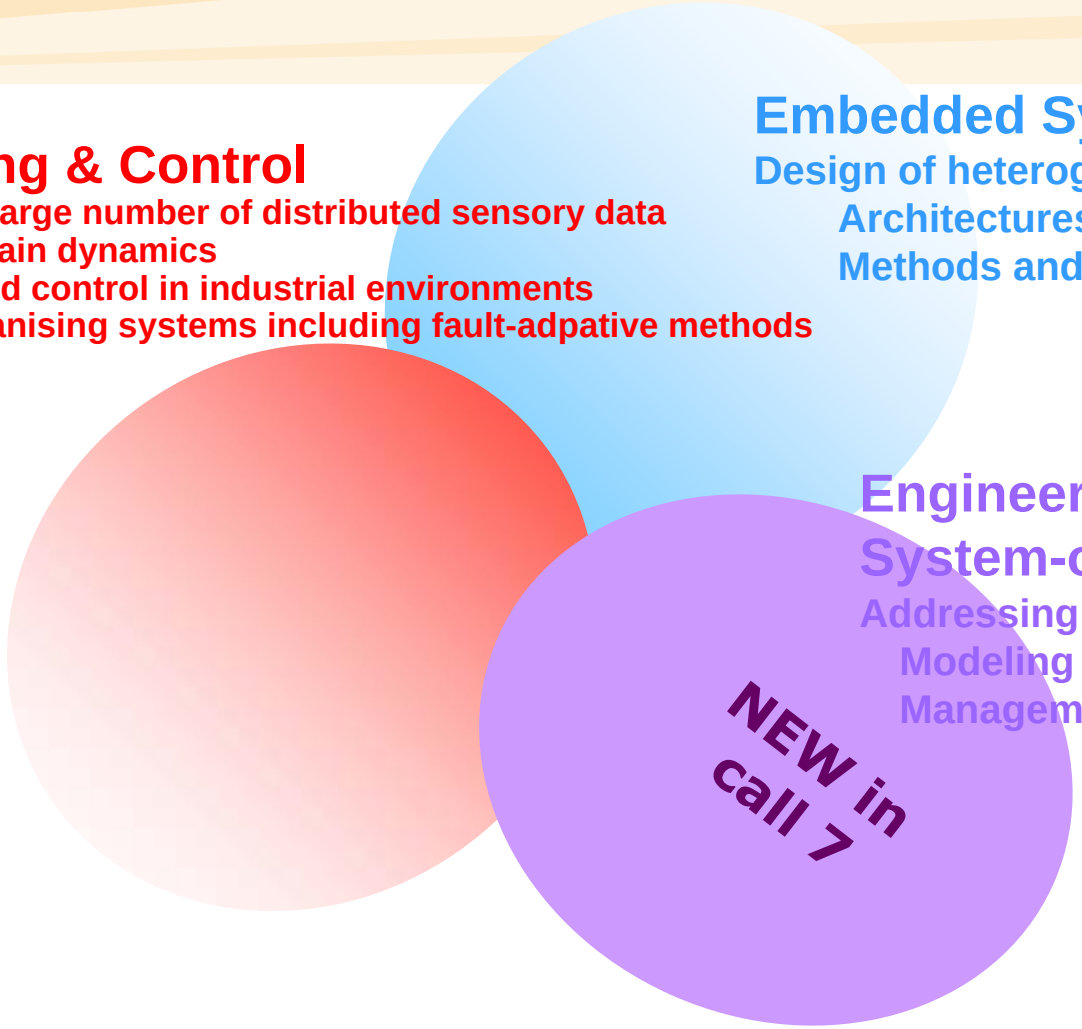


New paradigms for Embedded Systems, Monitoring & Control towards Complex Systems Engineering

Workprogramme 2010-2011 Objective 3.3 (Call 7)



Monitoring & Control

Dealing with large number of distributed sensory data and/or uncertain dynamics

- **Advanced control in industrial environments**
- **Self-organising systems including fault-adpative methods**

Embedded Systems Design

Design of heterogeneous Embedded Systems

- **Architectures**
- **Methods and Tools**

Engineering of System-of-Systems

Addressing societal needs

- **Modeling and simulation of systems**
- **Management of dynamics**

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Objective 3.3: New paradigms for embedded systems (ES), monitoring & control (M&C) towards complex systems engineering

Target outcomes:

- Design of advanced heterogeneous ES
  a) Architectures and tools for energy efficient ES
  b) Composition & verification methods and tools
- M&C techniques dealing with large number of distributed sensory data and/or uncertain dynamics
  c) Robust control and optimisation in industrial environments
  d) Energy-aware self-organising M&C systems, including fault-adaptive methods in case of failures
- Engineering of System-of-Systems (SoS) addressing societal needs
  e) Modelling and simulation of high level behaviour and interaction of the constituent systems; Management of dynamics of SoS
  f) Strategic roadmap and case studies
- Facilitate international cooperation
  g) Analysis of research agendas and joint R&D initiatives with USA for SoS and with Western Balcan Countries for M&C

Call 7 **50M€** **IP** (a-e), **STREP** (a-d), **CSA** (f,g)

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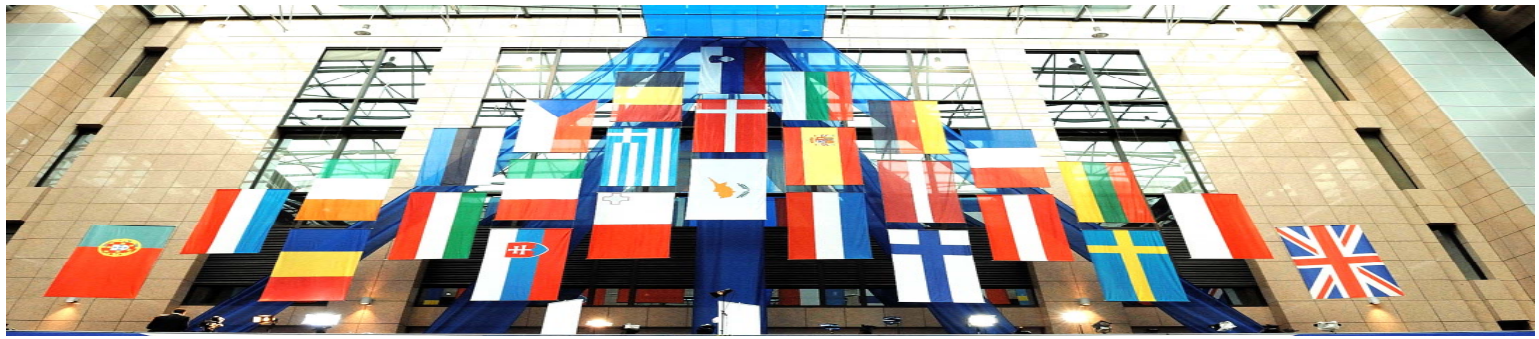


What is a “System-of-Systems”?

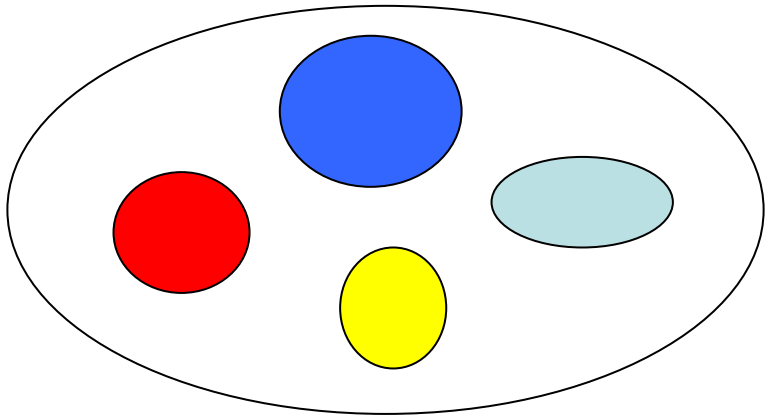
- Complexity of systems is growing
- Systems interact with an increasing number of other (embedded) systems due to an increasingly connected society and industry
- *A System-of-Systems* is composed of autonomous (embedded) systems that function as a complex system in order to satisfy a global need or multiple needs
- The overall system has to warrant certain (non-functional) properties: predictable, dependable, safe and secure
- A System-of-Systems is inherently interdisciplinary and heterogeneous

What is a “System-of-Systems” (SoS)?

Characteristics of a SoS vs. Monolithic Systems

Mark Maier, Systems Engineering, Vol1, Issue 4, 1998,
Architecting Principles for Systems-of-Systems

Elements of SoS are already large scale systems



- **Operational independence of the elements**
- **Managerial independence of the elements**
- **Evolutionary development**
- **Emergent behavior**
- **Geographic distribution of the elements**

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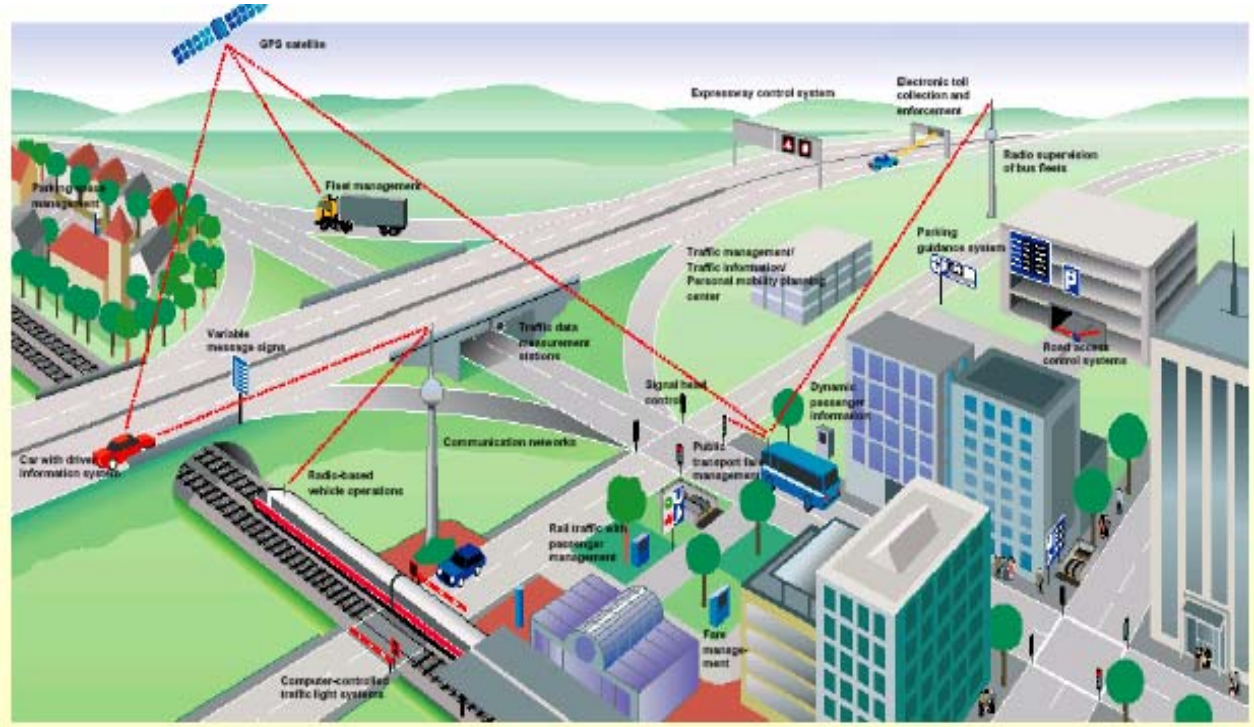
Why SoS Engineering?

- Reinforce leading position of European industry in system engineering
- Better use of existing resources and systems
- Facilitate global goal(s) or grand challenge(s)
- Societal applications of SoS for
  - Airport and air-traffic control, urban transport, water distribution, surveillance, smart grid for electricity, energy efficient buildings, enterprise and supply chain operations, health care
- "Engineering" is broader than "Design"
  - It covers also activities during deployment, operation and maintenance of systems
  - Correct-by-construction at design stage needs to be extended to operation stage

Example of Smart Grid

Example of Urban traffic control

System-of-Systems



- Traffic lights
- Public transport management
- Fire brigade / ambulance
- Collision warning
- Navigation
- Parking guidance
- Toll fee collection
- Fleet management
- Electric Vehicle charging stations

Example of Smart Home

System-of-Systems

- Building Envelope
- Energy Supply
- Energy Management
- Heating
- Cooling
- Ventilation
- Indoor Air-Quality
- Lighting
- Windows/Blinds
- Water
- Building automation
- Access control
- Operator qualification
- Maintenance

30-40% Energy savings can be achieved on a sustainable basis

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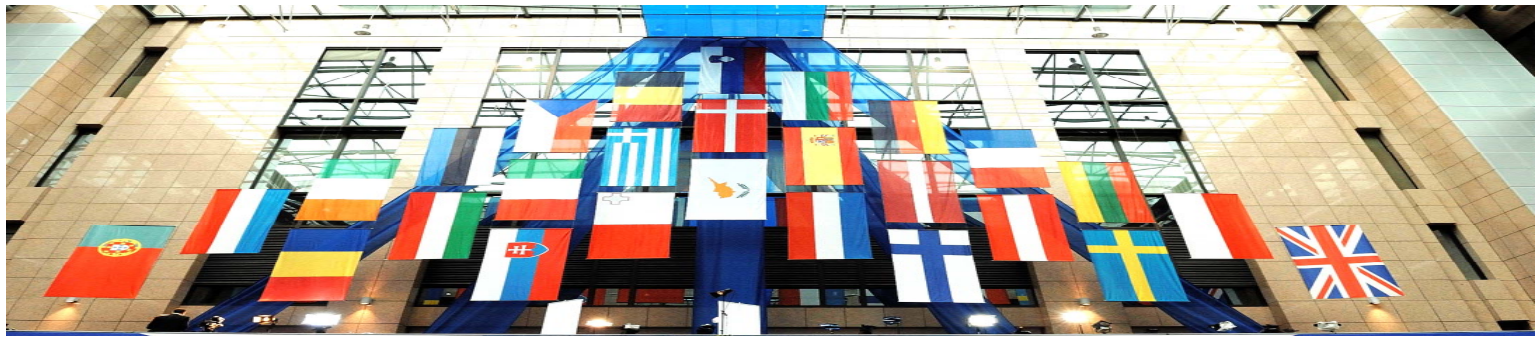

Publication: 28 Sep 2010
Deadline: 18 Jan 2011

Target outcomes 3.3.a and 3.3.b:

- Design of advanced heterogeneous ES,

  composed of independent components and sub-systems

  a) Architectures and tools for energy efficient ES
     - Emphasis on energy efficient and energy-aware ES
     - Key issues: dependability, scalability and heterogeneity
     - Projects may include enhancements of educational curricula

  b) Composition & verification methods and tools
     - Secure composition concepts
     - Novel validation/verification/testing tools

Instruments: IP and STREP

Objective 3.3: New paradigms for …, monitoring & control (M&C) ….

Publication: 28 Sep 2010
Deadline: 18 Jan 2011

Target outcomes 3.3.c and 3.3.d:

- M&C techniques dealing with large number of distributed sensory data and/or uncertain dynamics

  Aim to achieve stable and robust behaviour of real life system, in particular with closed loop(s)

  c) Robust control and optimisation in industrial environments

  d) Energy-aware self-organising M&C systems, including fault- adaptive methods in case of failures
     - Proof of concept must be demonstrated
     - Wireless sensor/actuator networks are allowed when relevant for closing of control loop

Instruments: IP and STREP

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Objective 3.3: … towards complex systems engineering

Publication: 28 Sep 2010
Deadline: 18 Jan 2011

Target outcomes 3.3.e and 3.3.f:

- Engineering of System-of-Systems (SoS) addressing societal needs

  Concepts, methods, architecture and tools. Demonstrate its potential use across several application sectors.

  e) Modelling and simulation of high level behaviour and interaction of the constituent systems;
     - Understand how common goal or global end-to-end optimisation can be realised
     - Heterogeneous systems: different mechanisms, different speeds, different models (behaviour, time), …
     - Dependability of safety critical systems with constituent systems having differing levels of safety criticality
     - Autonomy versus Cooperation of systems

     Management of dynamics of SoS
     - Constituent systems of SoS change, configuration of SoS change
     - Goals evolve

  f) Strategic roadmap and case studies
     - Bringing together relevant stakeholders for SoS

Instruments: IP (e) and CSA (f)

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Target outcome 3.3.g :

Facilitate international cooperation

g) Analysis of research agendas and joint R&D initiatives

- with USA in the area of SoS
- with Western Balcan Countries in the area of M&C

Instrument: CSA

Not exceeding 0.5 million € per proposal!

Separate proposal per geographic area!

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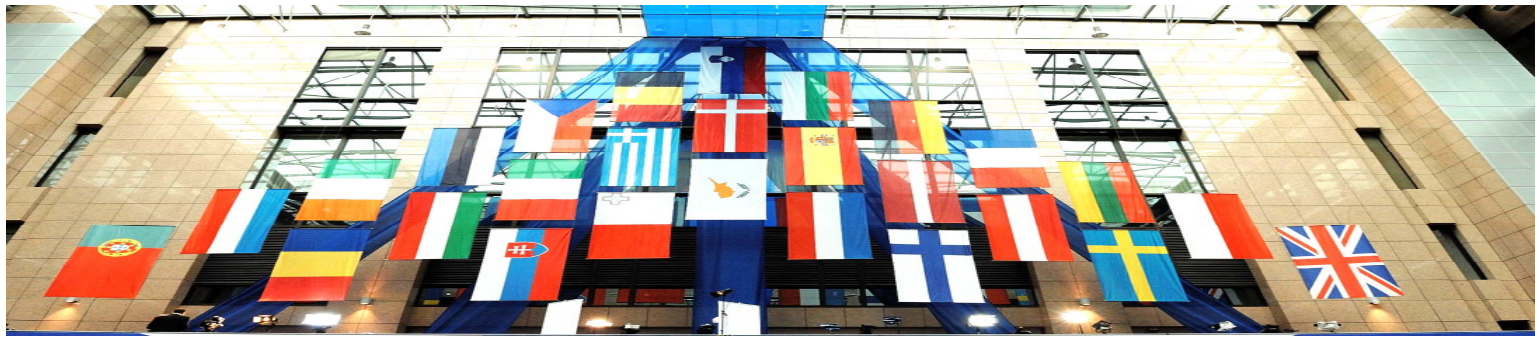

Evaluation criteria

- Evaluation criteria vary per funding scheme
  - Collaborative Projects (CP) =
    - large-scale Integrating Projects (IP) or
    - Small or medium-scale focused research projects (STREP)
  - Coordination Action (CA)
  - Support Action (SA)
- The majority of the proposals are STREP.

Evaluation criteria

1. **Scientific and/or technological excellence (relevant to the topics addressed by the call)**
2. **Quality and efficiency of the implementation and the management**
3. **Potential impact through the development, dissemination and use of project results**

List of Expected Impacts specified in the WP for the objective 3.3

- Improved industrial competitiveness (a-e)
- New business eco-systems providing innovative products and services based on SoS (e,f)
- Reinforced European scientific excellence and technological leadership in the design and operation of complex systems (a-e)
- Wider educational and training activities in systems and control engineering in Europe at all levels (a,b,d,e,f)
- International cooperation with targeted geographical areas creating mutual benefits which will further European interests on focused technical topics (g)

Instruments and Budget

Design of advanced heterogeneous ES **– STREP & IP**

a) Architectures and tools for energy efficient ES
b) Composition & verification methods and tools

M&C techniques dealing with large number of sensory data **– STREP & IP**

c) Robust control and optimisation in industrial environments
d) Energy-aware self-organising M&C systems

Engineering of System-of-Systems (SoS)

e) Modelling and simulation; Management of dynamics of SoS **– IP only**
f) Strategic roadmap and case studies **– CSA only**

Facilitate international cooperation – **CSA only, max € 0.5 M€ per proposal**

g) Analysis of research agendas and joint R&D initiatives

Budget: 50 M€

CP 46 M€ of which min. 50% to IPs and min. 30% to STREPs
CSA 4 M€

For Further Information

ICT:

http://cordis.europa.eu/fp7/ict

Embedded Systems Design and

Consultation workshop on System-of-Systems :

http://cordis.europa.eu/fp7/ict/esd/home_en.html

Networked Embedded and Control Systems
http://cordis.europa.eu/fp7/ict/necs

E-Mail : **philippe.reynaert@ec.europa.eu**

ICT Proposers' Day 2011
19 - 20 May, Budapest
Networking for European ICT R&D

- Aim of the event:
  to prepare for Calls 8 and 9 (together >1 billion €)
  - by networking and partnerships building
  - by first-hand information from >100 EC officials
- Structure:
  - thematic sessions with presentations of proposal ideas
  - information stands & meeting points
- Registration:
  free of charge, open from January 2011

http://ec.europa.eu/ictproposersday

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